Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

HOCHSCHULE BREMEN
UNIVERSITY OF APPLIED SCIENCES

Master 2012

Paresh Kumar Kakadiya

Optical Arbitrary Waveform Generator with Electronic Predistortion

ABSTRACT - Masterthesis

An optical arbitrary waveform generator (OAWG) is a key component of high capacity optical transmission links as they enable the flexible generation of various modulation formats such as binary phase shift keying (BPSK), quadrature phase shift keying (QPSK) and 16-quadrature amplitude modulation (16-QAM). In this thesis the OAWG which is a combination of an electrical AWG and an optical multi-format transmitter (OMFT), has been investigated in terms of signal quality with the main aim to improve the signal quality by implementation of a predistortion algorithm in offline software.

Generally the AWG introduces distortions due to memory effects under certain operating conditions, mainly caused by the limited bandwidth. The OMFT also introduces non-linear distortions when it is operated in the saturation regime in order to obtain better efficiency. To compensate these distortions, a Volterra predistortion model (VPDM) based on p^{th} order inverse of the non-liner system is implemented using the least square fitting algorithm and matrix inversion. Various artificial distortions (mainly caused by the memory effects and nonlinearity) are generated to test the capabilities and limitations of this model, and they are successfully compensated.

Applications of the VPDM in the real time electrical measurements have been executed and memory effects of the AWG is compensated with the gain of 1.4 dB (signal-to-noise) SNR at the bit error ratio (BER) of $2x10^{-3}$, for a predistorted 16-QAM signal as compared to a nonpredistorted 16-QAM signal. The non-linear distortions introduced by the electrical amplifiers are also compensated using the VPDM with the gain of 2 dB SNR at the BER of $2x10^{-3}$ for a 16-QAM Signal.

With a significant improvement using the VPDM in the electrical domain, its applications are extended to real time optical back-to-back measurements. In the beginning, the OAWG is operated in the linear regime and output signal quality has been improved by using the VPDM. Then the OAWG is operated in the non-linear regime and its performance is optimized for particular modulation formats. The implementation penalty at the BER of $2x10^{-3}$ is greatly reduced to 0.5 dB for BPSK and QPSK while it is 2.2 dB for 16-QAM signals using the VPDM.

In such a way, the VPDM plays a promising rote to achieve optimum transmitter performance from the OAWG with lower possible implementation penalty.